



An Underwriting Approach to Estimating the Cost of Property and Casualty Equity

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ARTICLE INFO

JEL Classification:

G22

G32

Keywords:

Cost of Equity

P&C Insurance Companies

Illiquid Risks

Financing Frictions

Strategic Planning

ABSTRACT

Accurately estimating the cost of equity is a critical corporate finance capability, which has been the subject of significant research, the results of which have uncovered a number of practical insights, such as the analytical value of multiple factors. This insight is often leveraged in practice; for example, consider the property and casualty (P&C) insurance industry where the Fama and French three-factor model is often employed. However, managerial use of this model has been hampered in certain cases by the fact that its size and book-to-market factors are disconnected from P&C considerations, and therefore the model's output can be of limited use to some P&C executives, especially executive-level underwriters. Several researchers have taken a different approach, one that is based on a traditional market risk premium as well as a premium for illiquid risks that must be retained within a firm due to, for example, financing frictions. This approach has been applied to the banking industry, which we have built on to develop a practically-oriented cost of equity model for P&C insurance companies based on both equity market and P&C market systematic risk factors. We have applied our approach at a number of insurance companies and therefore include real life-based examples that demonstrate its practical utility.

Journal of Insurance and Financial Management

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1. Introduction

The classic model to estimate the cost of equity is the capital asset pricing model (CAPM), which is popular with many financial executives (Graham and Harvey, 2015 and 2002). This model holds that the cost of equity is a function of the risk-free rate and sensitivity to changes in the equity market:

$$K_E = R_F + \beta_E * ERP \quad (1)$$

where

K_E = cost of equity

R_F = risk-free rate

β_E = sensitivity to changes in the equity market

ERP = equity risk premium = equity market risk (R_M) less the risk-free rate

Arbitrage pricing theory (APT) was subsequently developed based on the practical reality that systematic risk can be a function of more than one-factor (Roll and Ross, 1995):

$$K_E = R_F + \beta_1 * RP1 + \beta_2 * RP2 + \beta_3 * RP3 \dots \quad (2a)$$

where

β = sensitivity to changes in systematic factors 1, 2, 3 ...

RP = risk premium of systematic factors 1, 2, 3 ...

A number of multiple-factor models have been created. In the property and casualty (P&C) insurance industry, the three-factor Fama and French (1992) model has achieved a high level of popularity (e.g., Cummins and Phillips, 2003):

$$K_E = R_F + \beta_E * ERP + \beta_S * SRP + \beta_M * MRP \quad (2b)$$

where

β_S = sensitivity to changes in the size factor

SRP = size risk premium

β_M = sensitivity to changes in the book-to-market factor

MRP = book-to-market risk premium

First, it is important to note that this model is obviously not the only cost of equity model that may be used by P&C insurers, but it is the most popular,¹ which is why we will focus on it in this article. Second, viewed from a classical asset pricing perspective, one could argue that risks associated with both the size of a P&C insurer and its book-to-market position should be

¹ While admittedly anecdotal, we work with many large insurers across the globe and have found that many—if not most—of them employ the Fama and French model in some form or fashion in their strategic planning.

easy to either hedge or diversify away from in the modern capital markets. However, the fact that these factors both test reasonably well and are frequently used by P&C insurers suggests that these risks either cannot all be hedged or diversified away from, or that to do so is uneconomical or otherwise inefficient (e.g., at prohibitive terms and conditions).

During the course and scope of our work as financial advisors and researchers we questioned a number of insurers on their use of the Fama and French model. Many responded that the model's estimates more closely aligned with the qualitative rates of return required from their boards and executives. However, they cited a drawback with the model; namely, its factors are divorced from the P&C marketplace, which can complicate adoption of modeled output by some P&C executives, especially executive-level underwriters. While drawbacks like this are generally consistent with the systematic basis of asset pricing models in general, it does not alleviate the practical tensions inherent in operationalizing such models.

Several researchers have approached financial institution cost of equity estimation differently, from the perspective of both traditional capital markets risk as well as a premium for illiquid risks that must be retained within a firm. This approach has been successfully applied to the banking industry, which we built on to develop an underwriting-oriented cost of equity model for P&C insurers. Because our model includes a specific P&C risk premium we have found that its output is more readily acceptable to P&C executives, including and especially executive-level underwriters.

To demonstrate the utility of our approach we present three real-life-based examples, all of which have been disguised for presentation purposes. First, we apply our model to a basic risk transfer example. Second, we show how a P&C insurer applied our approach to estimate its cost of equity. Last, we profile how our approach was used at the business unit level of another P&C insurer to first estimate business unit hurdle rates, and then to facilitate its strategic planning.

2. The Cost of Equity and P&C Underwriting

Froot and Stein (1998) developed a two-factor asset pricing model for financial institutions that is based on both systematic capital markets risk as well as a premium for illiquid risks that must be retained within a firm. Their basic model is built on two core precepts: First, is the fundamental notion that illiquid risks which can neither be diversified away from nor hedged—either absolutely or effectively due to financing frictions—must be retained within a firm. The specific cause(s) of illiquidity is not important, only that risk retention is forced on a firm

because risk transfers that would occur in a more efficient marketplace cannot take place. Such a situation effectively calls for a risk premium in addition to the equity risk premium associated with the basic CAPM in cost of equity calculations (equation (1)). Second, the model applies to small projects relative to a financial institution's internal portfolio.

In explaining their approach, Froot and Stein (1998) present an example of a bank undertaking a project, the hurdle rate of which was estimated as follows:

$$K = R_F + \beta_E * ERP + \beta_N * Z \quad (3)$$

where

K = hurdle rate of a project funded by equity

B_N = sensitivity to changes in the new project factor, which is calculated as $cov(\text{new project, internal portfolio}) / var(\text{internal portfolio})$ where cov is covariance and var is variance

Z = price of unhedged risk

The second factor in equation (3) effectively “boosts the hurdle rate by an amount that is proportional to the new project's ‘internal portfolio beta’” (p. 63).² This approach, with some modification, lends itself to the practical evaluation of P&C insurer risk. To understand why, first consider that P&C insurance, like all forms of insurance, is based on the law of large numbers, which by way of background holds that the probability, p , of the average loss, $\sum_{i=1}^N Li / N$, will differ from the expected loss, $E(L)$, by more than a small number, ε , that approaches zero as the number of homogenous risks underwritten, N , approaches infinity:

$$p (| \sum_{i=1}^N Li / N - E(L) | > \varepsilon) \rightarrow 0 \text{ as } N \rightarrow \infty \quad (4a)$$

This expression shows that P&C insurers are designed to assume numerous relatively small risks; small relative to the size of an insurer's capital base—specifically, the equity capital base as insurers are evaluated on an equity rather than enterprise basis (e.g., Copeland, et al., 2000 [1990], p. 452)—and therefore its pre-existing internal portfolio. In fact, underwriting large risks relative to an insurer's capital base would result in uneconomical risk transfer. To understand why, note that P&C underwriting and pricing models calculate premium as a function of the number of homogenous risks underwritten and assumed, N , as the below basic pricing model illustrates:

² The example pertains to a foreign exchange swap whereby it was noted that the project's currency risk could be easily hedged while its credit risk had to be retained. The example in general predates the widespread use of credit derivatives, but its basic theory nevertheless holds.

$$Pr = E(L) + (c*s)N^{1/2}/N \quad (4b)$$

where

Pr = premium

c = confidence level

s = standard deviation

In addition to uneconomical risk transfer, the credit risk associated with a single large account loss relative to an insurer's capital base is not something that either insurance policyholders, intermediaries or regulators would generally allow.³ Therefore, P&C underwriting inherently pertains to relatively small risks.

The Froot and Stein criteria pertaining to the inability to transfer all unwanted risk at either economical prices and/or at fair terms and conditions may at first seem inapplicable to P&C insurance given the existence of both the sizeable global reinsurance market and the insurance linked securities (ILS) market. However, reinsurance companies seek to underwrite in accordance with the law of large numbers (expression (4a)) in much the same manner that insurance companies do, and as a result they are not always able to assume all of the risks their insurance clients may want to transfer (or cede) at either terms and conditions those insurers would consider fair and/or at prices they would consider economical. Furthermore, the P&C focus of ILS to date (mid-2016) has been predominantly on severe risks such as property natural catastrophes; however, the risk profile of most P&C insurance exposures, including most property exposures, is wider than property catastrophe.

A two-factor, marketplace-specific approach therefore lends itself to P&C cost of equity analysis. Before explaining how, it is important to first review the combined or underwriting ratio, which is the fundamental P&C performance measure:

$$U = (L + X) / Pr \quad (4c)$$

where

U = underwriting ratio for a P&C insurer, net of reinsurance

L = total loss payments, which is calculated as the sum of indemnification and loss adjustment expenses (paid and reserved) over a given time period, $\sum_{i=1}^N Li$

X = operating expenses

³ This is not to say that concentration of risk issues do not emerge from time-to-time such as those generated from natural catastrophes (e.g., earthquakes and hurricanes), manmade catastrophes (e.g., terrorism and industrial accidents) and so-called "casualty catastrophes" (i.e., numerous claims generated from one common cause of loss such as asbestos exposure, environmental accidents, product recall-related issues, etc.). Such issues do emerge and as a result a great deal of effort can be expended identifying and monitoring such risks; however, these activities are highly specialized and outside the scope of this introductory paper.

Pr = premium, which is derived or informed by pricing models such as (4b). In practice, the *loss ratio*, L/Pr , is calculated via *earned premium*, or the amount of premium collected by an insurance company over an accounting period that has been earned based on the ratio of the time passed on the policies to their effective life, while the *expense ratio*, X/Pr , is calculated via *written premium*, or the total amount of premium paid for insurance policies underwritten during an accounting period.

The underwriting ratio can serve as the basis of an accounting beta to estimate sensitivity to changes in a new P&C account, which equates to the β_N parameter in equation (3). Prior to demonstrating how, it is important to note that we depart somewhat from Froot and Stein (1998) in this application as they calculate their second factor based on unhedgeable risks only (p. 64). We have found with P&C underwriting that there tends to be no clear dividing line between hedgeable and unhedgeable risks due to the myriad ways that ceded reinsurance and ILS can, and cannot, be used at any one point in time in the P&C marketplace. Therefore, our working (and simplifying) assumption is that the covariance of unhedgeable P&C risks is relatively equal to that of hedgeable risks; in other words, and in the context of the underwriting ratio-based accounting beta that we will employ, gross of reinsurance underwriting profitability is relatively equal to net of reinsurance underwriting profitability (equation (4c)) over time. As such, frictions in the P&C marketplace that force risk retention limit the number of risks an insurer can underwrite (expression 4(a) and equation (4b)) thereby restricting float generation and the corresponding amount of investment income that can be earned, which reduces firm value. It is this foregone opportunity that we are evaluating.

To demonstrate the practical utility of our approach, consider the example of a commercial P&C insurer that is underwriting a new liability account and that, due to financing frictions, it either cannot cede or hedge all of the risk associated with this account, and as a result it must retain it. Based on analyses conducted at the time of the underwriting, this account's underwriting ratio covariance with the insurer's internal portfolio was calculated at approximately 0.36%, which when divided by the variance of the insurer's underwriting ratio of approximately 0.30% gives an underwriting ratio-based accounting beta of 1.2. This example is based on an actual analysis that has been disguised for presentation purposes; nevertheless, it highlights the practicality of our approach for P&C executives and underwriters alike in that it is consistent with the underlying nature of P&C pricing. To explain, when loss volatility, s , expands it should equate to higher pricing given the structure of P&C underwriting and pricing models (equation (4b)). This, in turn, will—assuming little-to-no diversification

benefits—translate to a relatively higher hurdle rate as: $cov(A_N, P_I) / var(P_I) = \beta_N = [s(A_N) / s(P_I)] * r(A_N, P_I)$, where A_N is the new insurance account in our example, P_I is the insurer's internal portfolio, and r is the correlation coefficient. This equivalence makes it relatively easy to explain modeled output to P&C executives and underwriters, which is a key benefit of our approach as will be demonstrated below. First, however, we continue with our example by way of estimating the cost of unhedged P&C risk, parameter Z in equation (3).

Financing frictions caused the insurer in this example to retain risk that it could not efficiently cede to reinsurers or the ILS market. The price of this risk was estimated as a function of P&C marketplace profitability (net profitability being an obviously driver of equity market returns that form the basis of equity risk premium estimates (equation (1)). Underwriting profitability is calculated as 100% minus the underwriting ratio, U , for reasons immediately apparent upon reviewing equation (4c). However, enterprise-wide P&C profitability is not simply the result of underwriting: P&C float is analogous to debt in that insurers collect money in the present with the expectation of paying it out sometime in the future. There can be significant levels of uncertainty in doing this—hence the p term in expression (4a)—but as we have seen, as the number of homogenous risks underwritten, N , grows large the differential loss, $\sum_{i=1}^N Li / N - E(L)$, compresses thereby facilitating the efficient pricing of risk (expression (4a) and equation (4b)) as reflected by little-to-no long-term market-wide underwriting profitability over time, $100\% - U_M \approx 0$ where U_M is the underwriting ratio of the P&C marketplace. However, because insurance liabilities “float” over time the money that is set-aside, or reserved, for loss payments can be invested until such times as it is needed to make those payments; hence, the debt analogy. Like all forms of debt, float has a cost: If the cost of insurance float, K_O , is less than market rates for money then insurance underwriting creates value even if underwriting operations produce a loss (Calandro and Lane, 2002). This dynamic can practically be captured by adjusting the standard underwriting profitability hurdle of 100% by the applicable risk-free rate:

$$K_O = (100\% + R_F') - U \quad (4d)$$

where

R_F' = risk-free rate at the estimated effective duration of insurance liabilities

The cost of float can be used to estimate a risk premium for the P&C marketplace. To demonstrate how, we first continue with our example and note that the insurer's financial analysts estimated the cost of float of the new liability account being underwritten at $3\% = Z$. Assume further a base CAPM-derived required rate of return of 7%, and it can be seen that,

following equation (3), the required rate of return for the new liability account in this example is $10.6\% = 7\% + (1.2 \times 3\%)$. As noted above, this result is easy to explain to both P&C executives and underwriters alike in that the new liability account in this example is relatively volatile when compared to the firm's internal portfolio; therefore, its required return is relatively high, but the account's volatility profile should equate to higher pricing thereby warranting a higher required return.

While this example is useful for illustration purposes, P&C insurers generally do not estimate required returns on an account-by-account basis.⁴ Rather, they tend to estimate the firm's cost of equity in preparation for annual strategic planning processes, and then use that estimate to create underwriting strategies expected to generate returns at, and preferably greater than, their cost of equity (per value-based management theory, which effectively began with Fruhan, 1979 and was popularized by Stewart, 1999 [1991]).⁵ As noted above, the Fama and French model is often used across the P&C industry to make cost of equity estimates; however, and as also noted above, practical difficulties can arise with its industry-agnostic factors. At such times, we have found it useful to employ a specific P&C risk premium in cost of equity calculations, which we accomplish by configuring equation (3) to estimate the cost of P&C equity via an underwriting ratio-based (equation (4c)) accounting beta and a cost of float-based (equation (4d)) P&C market premium:

$$K_{E,P/C} = R_F + \beta_E (R_M - R_F) + \beta_U ([100\% + R_F'] - U_M) \quad (5)$$

where

$K_{E,P/C}$ = Cost of P&C insurer equity

β_U = sensitivity to changes in the P&C marketplace = underwriting ratio accounting beta
 $= \text{cov}(U, U_M) / \text{var}(U_M)$

The business logic of this approach can be found in the fundamentals of the P&C marketplace. To explain, first consider the cyclical nature of P&C insurance that is illustrated in Figure 1. Volatility, s , is the driver of the cyclical behavior in that a short-term spike in marketplace differential losses, $\sum_{i=1}^N Li / N - E(L) > 0$, results in Pr increases (equation (4b)) that translate to greater levels of short-term market-wide underwriting profitability, $100\% - U_M > 0$ (equation (4c)). However, and as noted above, when N is very large, as it is in the P&C marketplace, the long-term market-wide differential loss is very small (expression (4a)) and therefore absent

⁴ Such estimates, like the one profiled in this example, tend to be made for select larger commercial and middle market accounts in contrast to personal insurance and small commercial accounts, which are rarely evaluated on this basis.

⁵ On the applicability of this theory to P&C insurance see Calandro (2006) and Calandro and Lane (2002).

some material and/or fundamental risk profile change, which is both rare and difficult to assess during periods of heightened volatility (there are behavioral explanations for this, e.g., Kunreuther, et al., 2013, p. 174), the increased Pr is transitory but nevertheless increases short-term market-wide underwriting profitability. The increased profitability attracts competitors even though over time s will contract leading to lower Pr that, also over time, causes underwriting profitability to revert back to the long-term market-wide mean, $100\% - U_M \approx 0$. This pattern results in a cyclical flow rather than a directional trend in that over the short-term the P&C marketplace overshoots both to the upside of high-levels of profitability as well as to the downside of underwriting losses, $100\% - U_M < 0$, prior to mean reverting. It is worth noting that currently (mid-2016) the U.S. P&C marketplace's average level of underwriting profitability (Table 1) is right where theory suggests that it should be as: $100\% - 99.83\% = 0.17 \approx 0$.⁶

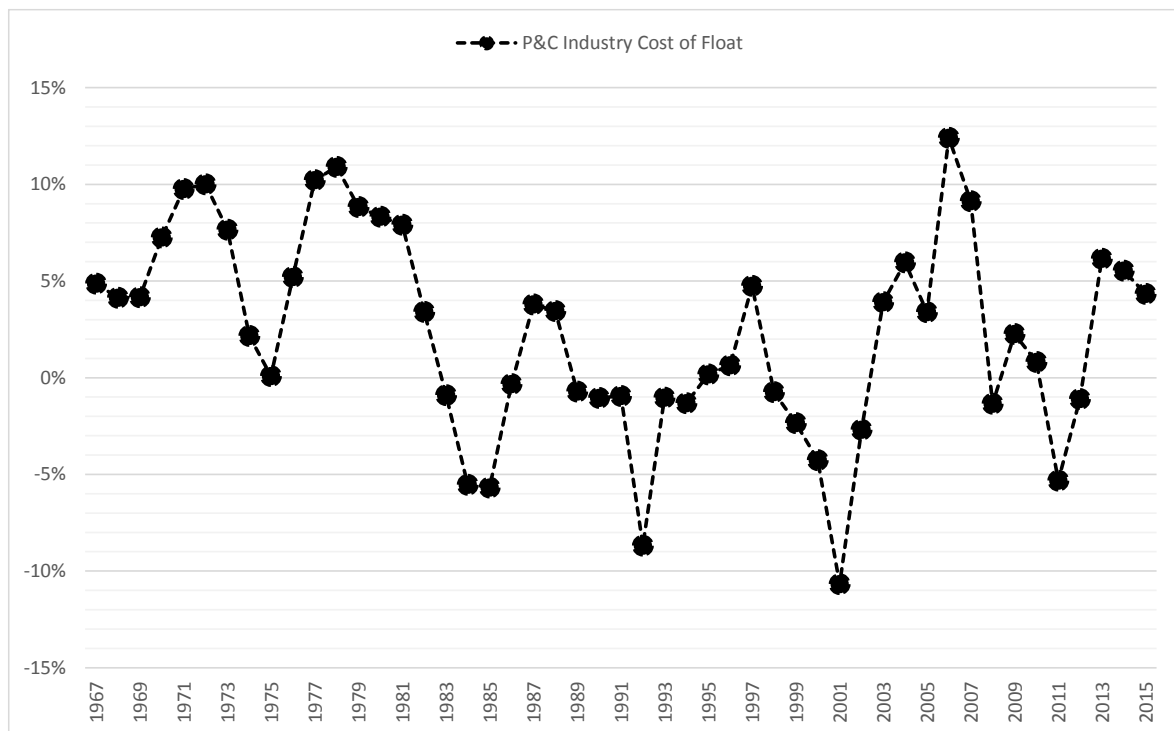


Figure 1
U.S. P&C Industry Cost of Float, 1967-2015

Note: Data sources are A.M. Best, Insurance Services Organization (ISO) and the Federal Reserve System. The average monthly 10-Year U.S. Treasury-Note yield was used as the annual risk-free rate (R_F) following equation (4d). All calculations are the authors' and have been rounded.

⁶ Cyclicity is generally a commercial P&C phenomenon; many believe that personal P&C insurance is no longer subject to cyclical effects, at least in the United States.

Therefore, to the extent an insurer is forced to retain risk in the P&C marketplace, the opportunity cost of this inefficiency can be estimated as a function of the insurer's sensitivity to changes in marketplace profitability. As such, if another P&C insurer is not forced to retain risk in this marketplace, then they would not be exposed to a P&C risk premium and thus the second factor in equation (5) drops off leaving the cost of equity as given by the CAPM (equation (1)).

Table 1
P&C Industry Cost of Float, 2005-2015

Year	Risk-free Rate (R_F)	Underwriting Profitability Hurdle	Marketplace Underwriting Ratio (U_M)	P&C Industry Cost of Float ($K_{O,M}$)
(a)	(b)	(c)=100%+(b)	(d)	(e)=(c)-(d)
2006	4.80%	104.80%	92.40%	12.40%
2007	4.60%	104.60%	95.50%	9.13%
2008	3.70%	103.70%	105.00%	-1.34%
2009	3.30%	103.30%	101.00%	2.26%
2010	3.20%	103.20%	102.40%	0.82%
2011	2.80%	102.80%	108.10%	-5.32%
2012	1.80%	101.80%	102.90%	-1.10%
2013	2.40%	102.40%	96.20%	6.15%
2014	2.50%	102.50%	97.00%	5.54%
2015	2.10%	102.10%	<u>97.80%</u>	<u>4.34%</u>
10-Year Average:			99.83%	3.29%
Sample Variance:			0.24%	
Sample Standard Deviation:				5.31%

Note: Data sources are A.M. Best, Insurance Services Organization (ISO) and the Federal Reserve System. The average monthly 10-Year U.S. Treasury-Note yield was used as the annual risk-free rate (R_F) following equation (4d). All calculations are the authors' and have been rounded.

3. Application

The following example is based on another actual analysis we performed for a P&C insurer that presented us with a traditional CAPM-derived cost of equity calculation in advance of its annual strategic planning process. Their calculation was similar to calculations (a) through (e) in Table 2 (as noted above, all examples presented in this paper have been disguised for presentation purposes). This insurer felt the estimated 8.51% cost of equity (calculation (e) in the table) was too low and as such wanted, in essence, to give it "a boost." Prior to retaining us they employed the Fama and French model to accomplish this, and while it resulted in a higher cost of equity estimate, that estimate was reportedly difficult to explain to the firm's executives and underwriters, and therefore it did not enable strategic planning and allocative efficiency (executive-level underwriters reportedly rejected the higher rates of return because those rates

did not reconcile to the realities of the marketplace in which they were attempting to underwrite). As such, the insurer desired a solution that was both consistent with existing asset pricing theory and relatively easy to explain to their executives, especially their executive-level underwriters.

We applied equation (5) to this insurer, which resulted in a cost of P&C insurer equity, $K_{E,P/C}$, of 12.14% per calculations (f) through (k) in Table 2. As can be seen, calculation (f) gives an underwriting covariance of 0.26%, which when divided by the variance of the P&C marketplace's underwriting ratio of 0.24% (Table 1) gives an underwriting ratio-based accounting beta, β_U , of 1.1 (calculation (h)). Our estimate of the P&C marketplace's cost of float, $K_{O,M}$, is the simple ten-year average from Table 1 shown in calculation (i). Multiplying calculation (h) by (i) gives a P&C risk premium, PRP , of 3.63%, which when added to the base CAPM estimate of 8.51% (calculation (e)) gives $K_{E,P/C}$ of 12.14%, as shown in calculation (k) of the table.

Table 2
P&C Insurance Company Cost of Equity Example

Calculation			Sources
(a)	Risk-Free Rate (R_F)	1.59%	10-Year Treasury Note Yield on 07/18/2016: http://www.federalreserve.gov/releases/h15/data.htm
(b)	Equity Beta (β_E)	1.3	Given
(c)	Risk Premium ($R_M - R_F$)	5.32%	Annual estimate accessed on 07/18/2016: http://pages.stern.nyu.edu/~adamodar/
(d)=(b)*(c)	Equity Risk Premium (ERP)	6.92%	
(e)=(a)+(d)	CAPM Cost of Equity Estimate	8.51%	
(f)	$cov(U, U_M)$	0.26%	Given
(g)	$var(U_M)$	0.24%	Table 1
(h)=(f)/(g)	Underwriting Accounting Beta (β_U)	1.10	
(i)	P&C Market Cost of Float ($K_{O,M}$)	3.29%	Table 1
(j)=(h)*(i)	P&C Risk Premium (PRP)	3.63%	
(k)=(e)+(j)	Cost of P&C Insurer Equity ($K_{E,P/C}$)	12.14%	

Note: all calculations are subject to rounding.

4. Conclusion

Successful long-term P&C underwriting is not easy in a marketplace as relatively efficient as the P&C marketplace, and therefore P&C executives and underwriters are increasingly demanding analytical insights that can better inform the strategic planning that guides their allocation of capital and resulting underwriting activities. We have employed the approach presented in this paper in a number of ways to help satisfy this demand in certain cases.

First, the combined equity market and P&C market basis of our approach helps simplify presentations of modeled output to P&C stakeholders thereby facilitating acceptance and usage of that output. Second, the structure of our model readily lends itself to business unit analyses, which further enables P&C strategic planning. To explain, because the second factor in equation (5) is an underwriting ratio-based accounting beta it can easily be configured to calculate an internal portfolio beta: from $cov(U, U_M) / var(U_M)$ to $cov(U_B, U) / var(U)$ where U_B is the business unit underwriting ratio.⁷ Such a dynamic establishes a direct linkage between an insurer's cost of equity and its business units' hurdle rates that can powerfully enable P&C strategic planning and capital allocation. Third, output from our model directly facilitates mean-variance-based underwriting portfolio analysis further enabling strategic planning.

For example, underwriting and financial data was provided to us from another P&C insurer, which was interested in leveraging insights from financial analyses in strategic planning. After estimating the hurdle rates for a number of their business units, we used their data to evaluate their units' underwriting portfolios via a basic mean-variance analysis, one output of which was a graphic similar to Figure 2 (as with the above, this example has been disguised for presentation purposes). In this case, the insurer's business unit was considerably more volatile than the firm and the mean-variance diagram practically illustrates why. A number of questions were prepared to help inform the insurer's strategic planning process such as:

- The product line to the upper-left in the oval generally has the same return as the product lines toward the left of the figure even though it is much more volatile: If the unit is not able to price for this product line's volatility (equation (4b)), should capital be allocated away from it and toward the less volatile product line(s)? If not, why not?

⁷ Business unit analysis can be readily accomplished on a loss ratio basis (equation (4c)) when unit expense ratios do not materially differ from that of the firm.

- The product line to the lower-right in the oval has the lowest return and is the most volatile; therefore, it seemingly should no longer be funded. If the unit disagrees, they should be asked to explain why.

Questions such as these can help to inform P&C strategic planning thereby contributing to greater levels of allocative efficiency over time. Furthermore, the joint equity market and P&C market basis of our approach could help to set the foundation for modeling solutions that generate insights into the interaction of both markets, and their related risk premiums, over time.

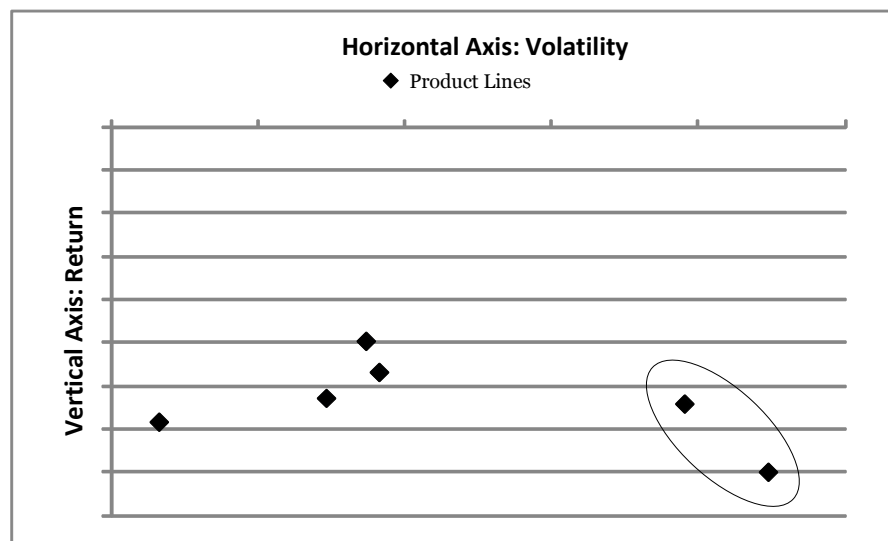


Figure 2
Business Unit Underwriting Portfolio Analysis Example

Note: This example is based on the different product lines of a P&C insurer, the identity of which has been disguised for presentation purposes. See Calandro, et al. (2015) for more information on business unit hurdle rates and portfolio analysis.

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